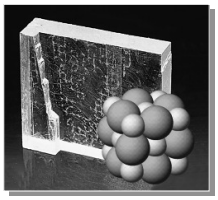
Welcome to the World of Chemistry



Scientific Method

1. State the problem clearly.
2. Gather information.
3. Form a hypothesis (educated guess)
4. Test the hypothesis.
5. Evaluate the data to form a conclusion.

   If the conclusion is valid, then it becomes a theory. If the theory is found to be true over along period of time (usually 20+ years) with no counter examples, it may be considered a law.
6. Share the results.

What is Scientific Notation?

- **Scientific notation is a way of expressing really big numbers or really small numbers. It is more concise.**
- **Sci Notation has 2 parts:**
  - **»A number between 1 and 10**
  - **»A power of 10**

$$\text{number} \times 10^{x}$$

To change standard form to scientific notation…

- **There should be one non-zero digit on the left of the decimal point.**
- **The number of decimal places the decimal point has "moved" from the original number is the exponent.**
  - **If the original number was:**
    - **<1 the exponent is negative**
    - **>1the exponent is positive.**

- **Given: 289,800,000**
- **Use: 2.898 (moved 8 places)**
- **Answer: 2.898×10^{8}**
- **Given: 0.000567**
- **Use: 5.67 (moved 4 places)**
- **Answer: 5.67×10^{-4}**

To change scientific notation to standard form…

- **Move the decimal point to the right for positive exponent.**
- **Move the decimal point to the left for negative exponent.**
  - **The exponent shows how many places to move**
  - **Use zeros to fill in places**
- **Given: 5.093×10^{6}**
- **(moved 6 places to the right)**
- **Answer: 5,093,000**
- **Given: 1.976×10^{-4}**
- **(moved 4 places to the left)**
- **Answer: 0.0001976**

UNITS OF MEASUREMENT

Use SI units — based on metric system

Length (distance traveled)	**Meter, m**
Mass (matter in a substance)	**Kilogram, kg**
Volume (space matter occupies)	**Liter, L**
Time (how long)	**Seconds, s**
Temp (heat of matter)	**Celsius degrees, ˚C kelvins, K**

Metric Prefixes

Prefix	Symbol	Multiplier	
exa	E	10^{18}	1,000,000,000,000,000,000
peta	P	10^{15}	1,000,000,000,000,000
tera	T	10^{12}	1,000,000,000,000
giga	G	10^{9}	1,000,000,000
mega	M	10^{6}	1,000,000
kilo	k	10^{3}	1,000
hecto	h	10^{2}	100
deka	da	10^{1}	10
deci	d	10^{-1}	0.1
centi	c	10^{-2}	0.01
milli	m	10^{-3}	0.001
micro	μ	10^{-6}	0.000,001
nano	n	10^{-9}	0.000,000,001
pico micro micro	p $\mu\mu$	10^{-12}	0.000,000,000,001
femto	f	10^{-15}	0.000,000,000,000,001
atto	a	10^{-18}	0.000,000,000,000,000,001

Metric Prefixes

Height	Volume	Weight
skyscraper 0.35 kilometers 3.5 hectometers 35 dekameters 350 meters 3500 decimeters 35000 centimeters 350000 millimeters	bottle 0.002 kiloliters 0.02 hectoliters 0.2 dekaliters 2 liters 20 deciliters 200 centiliters 2000 milliliters	cat 5 kilograms 50 hectograms 500 dekagrams 5000 grams 50000 decigrams 500000 centigrams 5000000 milligrams
film 0.000035 kilometers 0.00035 hectometers 0.0035 dekameters 0.035 meters 0.35 decimeters 3.5 centimeters 35 millimeters	medicine 0.00002 kiloliters 0.0002 hectoliters 0.002 dekaliters 0.02 liters 0.2 deciliters 2 centiliters 20 milliliters	cherries 0.005 kilograms 0.05 hectograms 0.5 dekagrams 5 grams 50 decigrams 500 centigrams 5000 milligrams

Learning Check

Select the unit you would use to measure

1. Your height

a) millimeters b) meters c) kilometers

2. Your mass

a) milligrams b) grams c) kilograms

3. The distance between two cities

a) millimeters b) meters c) kilometers

4. The width of an artery

a) millimeters b) meters c) kilometers

Conversion Factors

Fractions in which the numerator and denominator are EQUAL quantities expressed in different units

Example: **1 in. = 2.54 cm**

Factors: $\frac{\text{1 in.}}{\text{2.54 cm}}$ **and** $\frac{\text{2.54 cm}}{\text{1 in.}}$

Steps to Problem Solving

1. **Write down the given amount (with units). Don't forget the units!**
2. **Multiply by a conversion factor.**
   a) Put the unit that matches the given in the bottom (with its value) & the other unit & value in the top.
3. **Multiply across the top, then the bottom**
   a) Divide these 2 numbers
4. **If the units are not the ones you want for your answer, make more conversions until you reach that point.**
5. **Check for reasonability!!**

How many minutes are in 2.5 hours?

Conversion factor

$$2.5\ \text{hr} \times \frac{60\ \text{min}}{1\ \text{hr}} = 150\ \text{min}$$

cancel

By using dimensional analysis / factor-label method, the UNITS ensure that you have the conversion right side up, and the UNITS are calculated as well as the numbers!

Sample Problem

- **You have $7.25 in your pocket in quarters. How many quarters do you have?**

$$7.25 \text{ dollars} \times \frac{4 \text{ quarters}}{1 \text{ dollar}} = 29 \text{ quarters}$$

Learning Check

How many seconds are in 1.4 days?

$$1.4 \text{ day} \times \frac{24 \text{ hr}}{1 \text{day}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{60 \text{ sec}}{1 \text{ min}}$$

English and Metric Conversions

- **If you know ONE conversion for each type of measurement, you can convert anything!**
- **You must memorize and use these common conversions:**
  - **Mass: 454 grams = 1 pound**
  - **Length: 2.54 cm = 1 inch**
  - **Volume: 0.946 L = 1 quart**

Learning Check

An adult human has 4.65 L of blood. How many gallons of blood is that?

Unit plan: L ⟶ qt ⟶ gallon

Equalities: 1 quart = 0.946 L
1 gallon = 4 quarts

Your Setup:

Temperature Scales

- **Fahrenheit**
- **Celsius**
- **Kelvin**

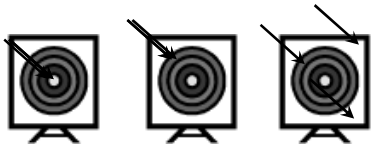
	Fahrenheit	Celsius	Kelvin
Boiling point of water	212 ˚F	100 ˚C	373 K
	180˚F	100˚C	100 K
Freezing point of water	32 ˚F	0 ˚C	273 K

Calculations Using Temperature

- **Generally require temp's in kelvins**
- **T (K) = t (˚C) + 273.15**
- **Body temp = 37 ˚C + 273 = 310 K**
- **Liquid nitrogen = -196 ˚C + 273 = 77 K**

Can you hit the bull's-eye?

Three targets with three arrows each to shoot.

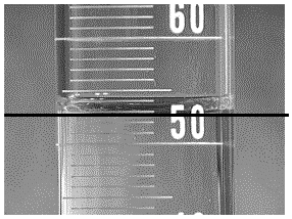


How do they compare?

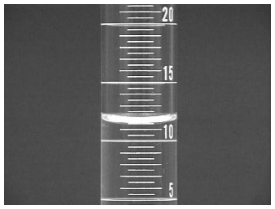
Both accurate and precise	Precise but not accurate	Neither accurate nor precise

Can you define accuracy and precision?

Always estimate ONE place past the smallest mark!



52.9



Significant Figures

- **The numbers reported in a measurement are limited by the measuring tool**
- **Significant figures in a measurement include the known digits plus one estimated digit**

Counting Significant Figures

RULE 1. All non-zero digits in a measured number are significant. Only a zero could indicate that rounding occurred.

	Number of Significant Figures
38.15 cm	**4**
5.6 ft	**2**
65.6 lb	____
122.55 m	____

Leading Zeros

RULE 2. Leading zeros in decimal numbers are NOT significant.

	Number of Significant Figures
0.008 mm	**1**
0.0156 oz	**3**
0.0042 lb	_____
0.000262 mL	_____

Sandwiched Zeros

RULE 3. Zeros between nonzero numbers are significant. (They can not be rounded unless they are on an end of a number.)

	Number of Significant Figures
50.8 mm	**3**
2001 min	**4**
0.702 lb	___
0.00405 m	___

Trailing Zeros

RULE 4. Trailing zeros in numbers without decimals are NOT significant. They are only serving as place holders.

	Number of Significant Figures
25,000 in.	**2**
200. yr	**3**
48,600 gal	**___**
25,005,000 g	**___**

Learning Check

A. Which answers contain 3 significant figures?

1) 0.4760 2) 0.00476 3) 4760

B. All the zeros are significant in

1) 0.00307 2) 25.300 3) 2.050×10^3

C. 534,675 rounded to 3 significant figures is

1) 535 2) 535,000 3) 5.35×10^5

Learning Check

In which set(s) do both numbers contain the *same* number of significant figures?

1) 22.0 and 22.00

2) 400.0 and 40

3) 0.000015 and 150,000

Significant Numbers in Calculations

- A calculated answer cannot be more precise than the measuring tool.
- A calculated answer must match the least precise measurement.
- Significant figures are needed for final answers from
  1) adding or subtracting
  2) multiplying or dividing

Adding and Subtracting

The answer has the same number of decimal places as the measurement with the fewest decimal places.

25.2 *one decimal place*
+ 1.34 *two decimal places*
26.54
answer 26.5 *one decimal place*

Learning Check

In each calculation, round the answer to the correct number of significant figures.

A. 235.05 + 19.6 + 2.1 =
1) 256.75 2) 256.8 3) 257

B. 58.925 - 18.2 =
1) 40.725 2) 40.73 3) 40.7

Multiplying and Dividing

Round (or add zeros) to the calculated answer until you have the same number of significant figures as the measurement with the fewest significant figures.

Learning Check

A. 2.19 X 4.2 =

1) 9 2) 9.2 3) 9.198

B. 4.311 ÷ 0.07 =

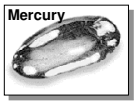
1) 61.58 2) 62 3) 60

C. $\frac{2.54 \times 0.0028}{0.0105 \times 0.060}$ =

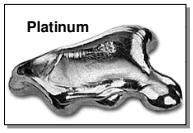
1) 11.3 2) 11 3) 0.041

DENSITY - an important and useful physical property

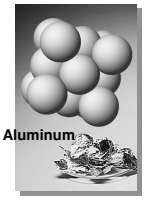
$$\text{Density} = \frac{\text{mass (g)}}{\text{volume (cm}^3\text{)}}$$



13.6 g/cm^3



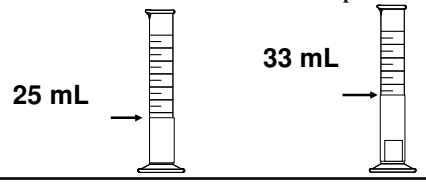
21.5 g/cm^3



2.7 g/cm^3

Finding Volume (V)

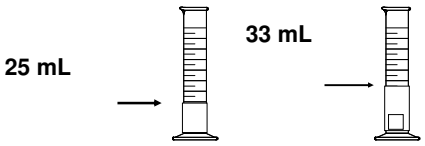
- **For regular shapes:**
  - » $V_{rectangle}$ = length x width x height
  - » $V_{cylinder} = \pi r^2 h$ (r = radius; h = height)
- **For irregular shapes:**
  - » **Water displacement:** A solid displaces a matching volume of water when the solid is placed in water.



Learning Check

What is the density (g/cm^3) of 48 g of a metal if the metal raises the level of water in a graduated cylinder from 25 mL to 33 mL?

1) 0.2 g/ cm^3 2) 6 g/m^3 3) 252 g/cm^3



Learning Check

If blood has a density of 1.05 g/mL, how many liters of blood are donated if 575 g of blood are given?

1) 0.548 L
2) 1.25 L
3) 1.83 L